Issues in SN cosmology

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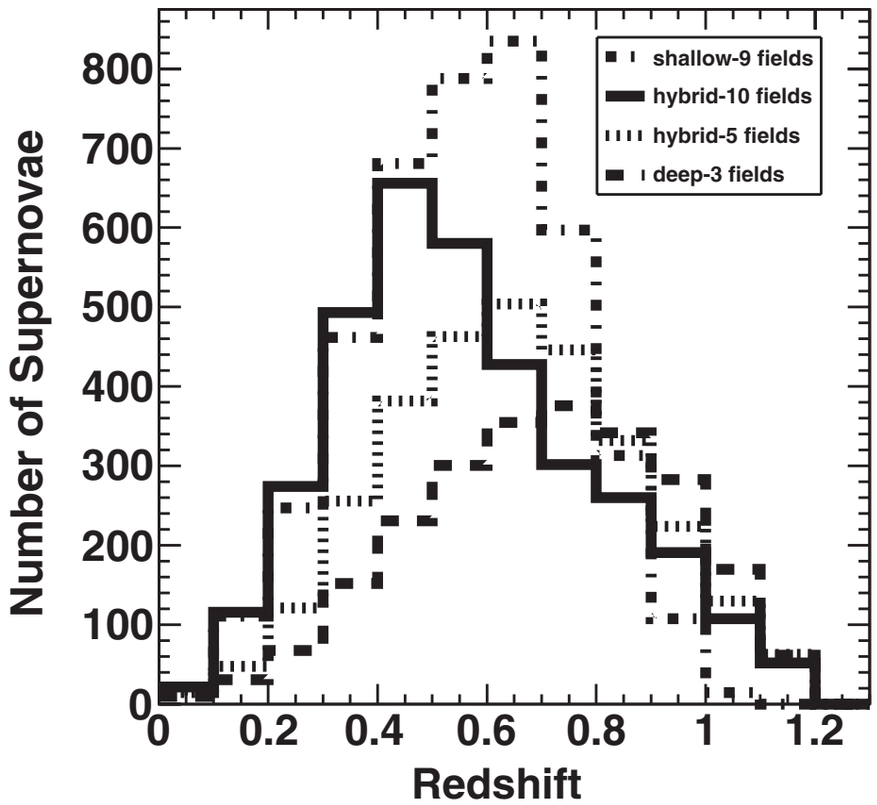
SN Cosmology: Goals

- Want to get better estimate of cosmological parameters
- Probe deeper redshift, with small correct error bars

So ...

Bernstein etal. Apj, 2012 (DES SN simulations)



Redshift	rms	rms/$\sqrt{N}$
0.0–0.1	0.17	0.0350
0.1–0.2	0.15	0.0140
0.2–0.3	0.14	0.0082
0.3–0.4	0.16	0.0073
0.4–0.5	0.17	0.0068
0.5–0.6	0.18	0.0075
0.6–0.7	0.18	0.0086
0.7–0.8	0.21	0.0120
0.8–0.9	0.23	0.0150
0.9–1.0	0.25	0.0180
1.0–1.1	0.21	0.0200
1.1–1.2	0.17	0.0240

Large, homogeneous, precise sample for cosmology
unprecedented demands on systematics

How are the numbers achieved?

- Photometric Typing: For SDSS number ~ 3+ times, but core collapse contamination
- improved technology/time: probe many SN in high redshift range

The systematic effects come in through the standardization procedure:

Incorporating observational errors

What are the model errors involved

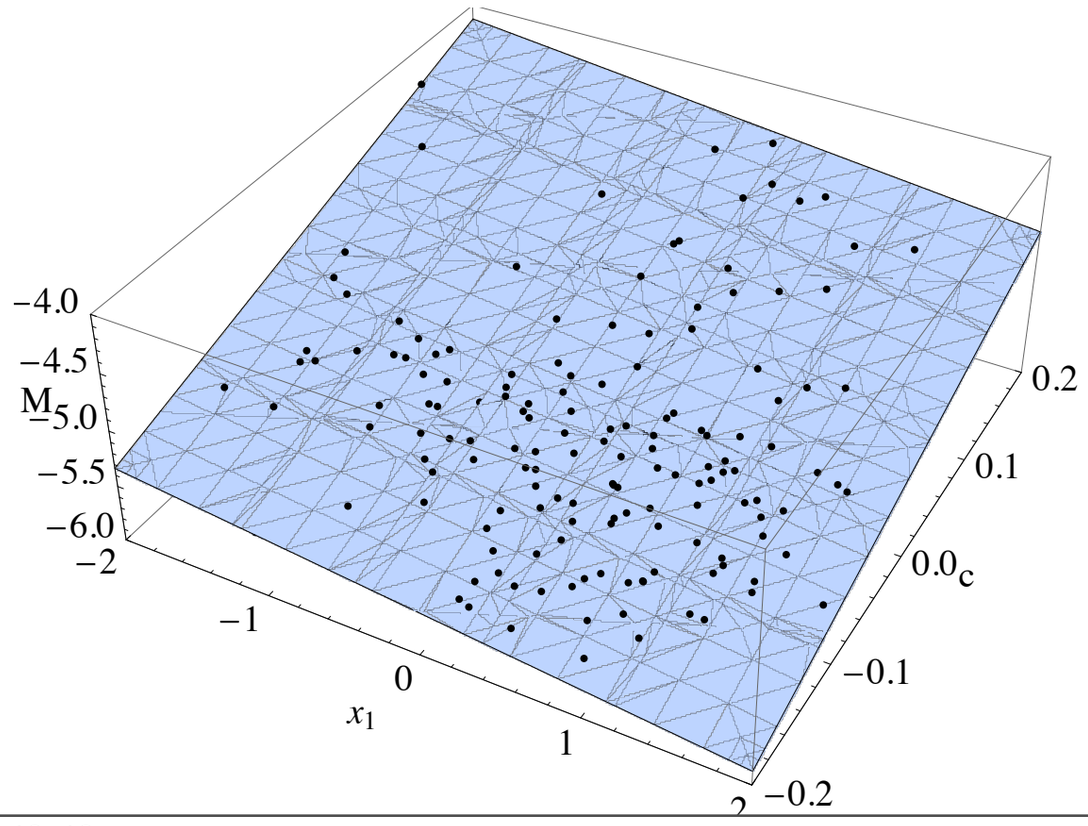
Standardization

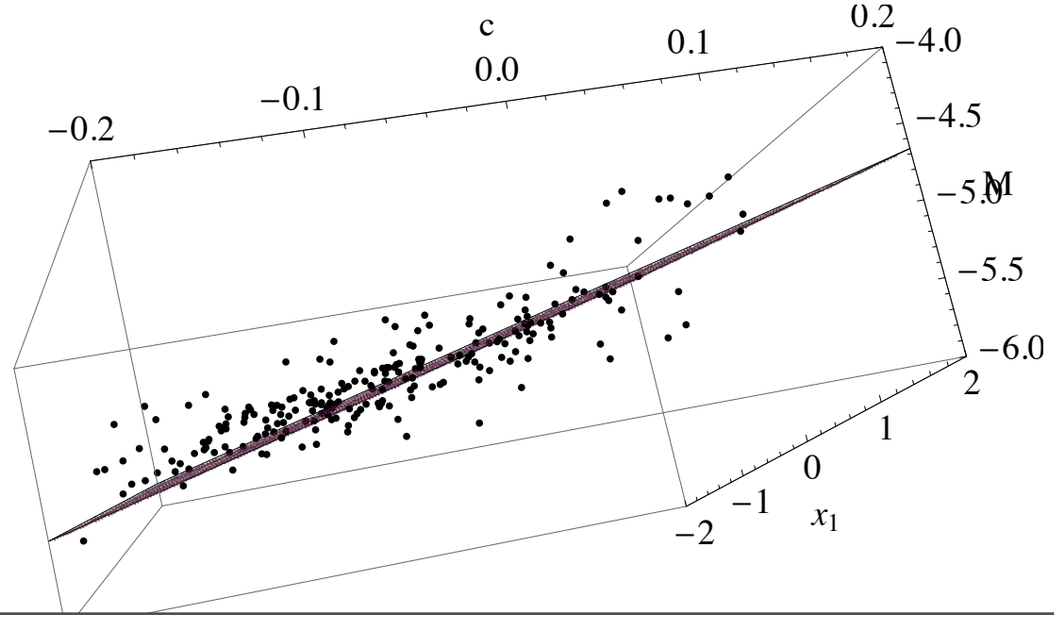
SN properties are correlated, cluster around a surface

$$M + \alpha x_1 - \beta c + m0 = 0$$

abs mag

measurable SN properties





SALT2 Model: data driven

Global parameters : From Training

$$F(SN,\lambda,p) = x_0\,(M_0(\lambda,p) + x_1 M_1(\lambda,p))\,Exp(-cCL(\lambda))$$

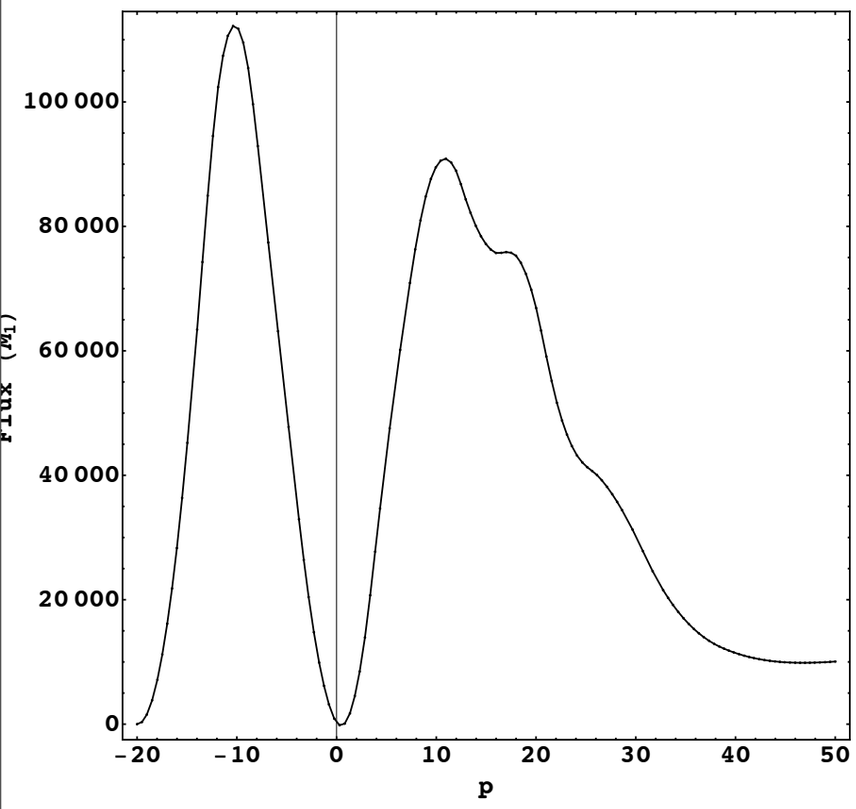
observed amplitude

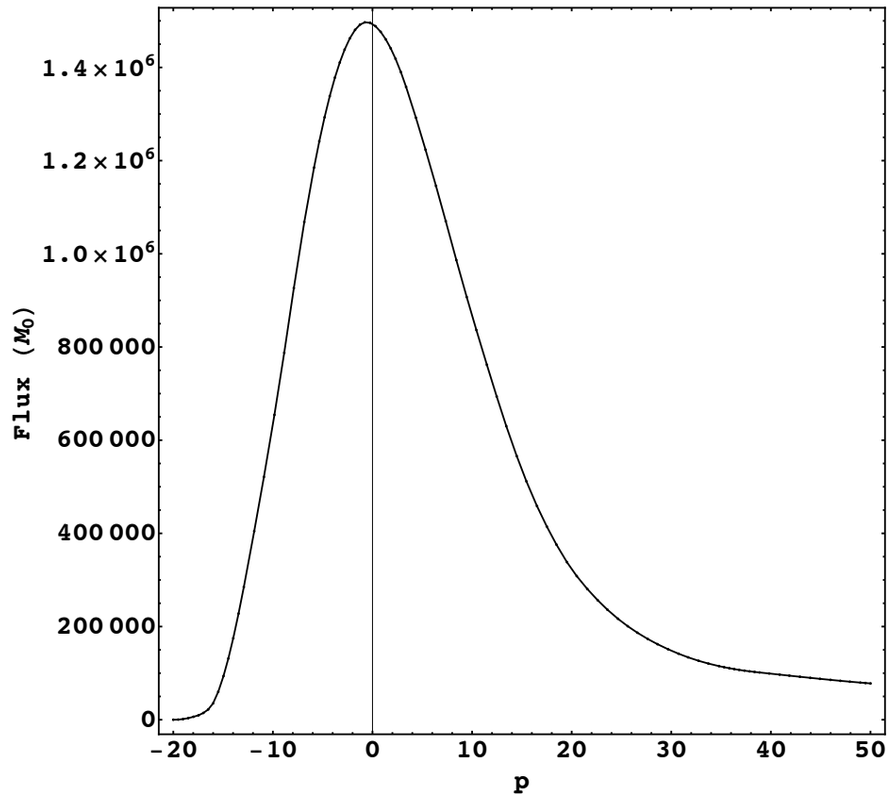
width of LC

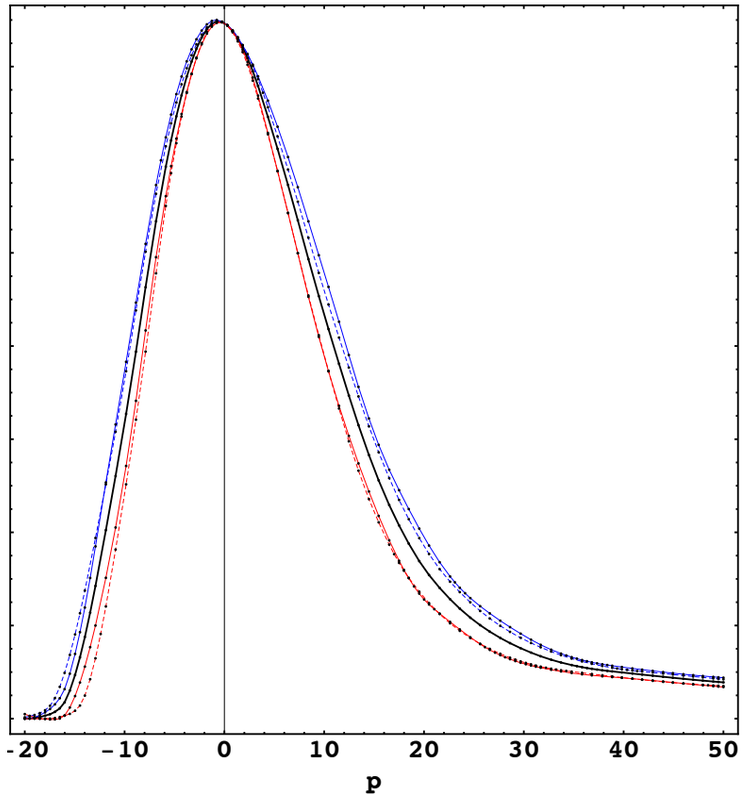
Ratio of peak mags

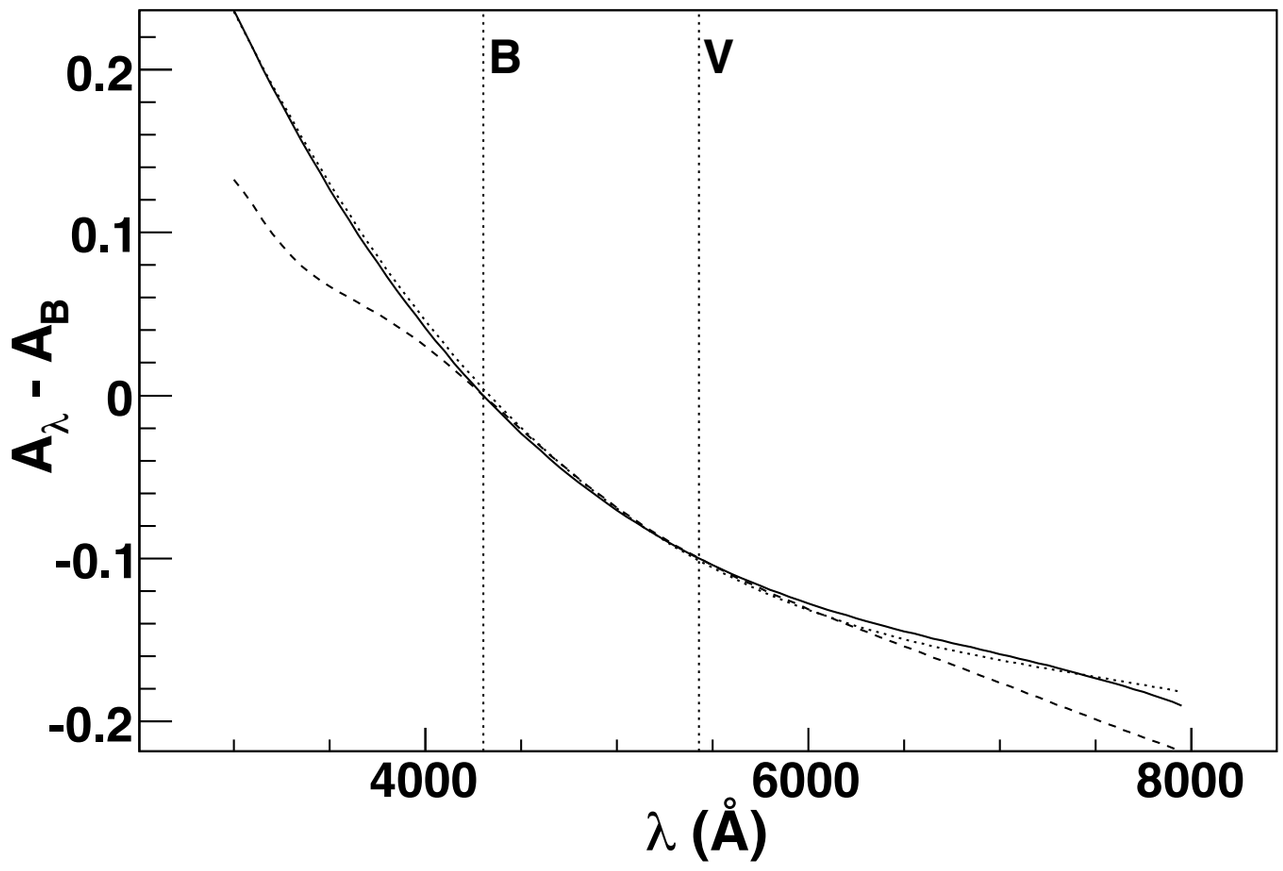
SN observables: measurable from light curves

x1 maps to stretch

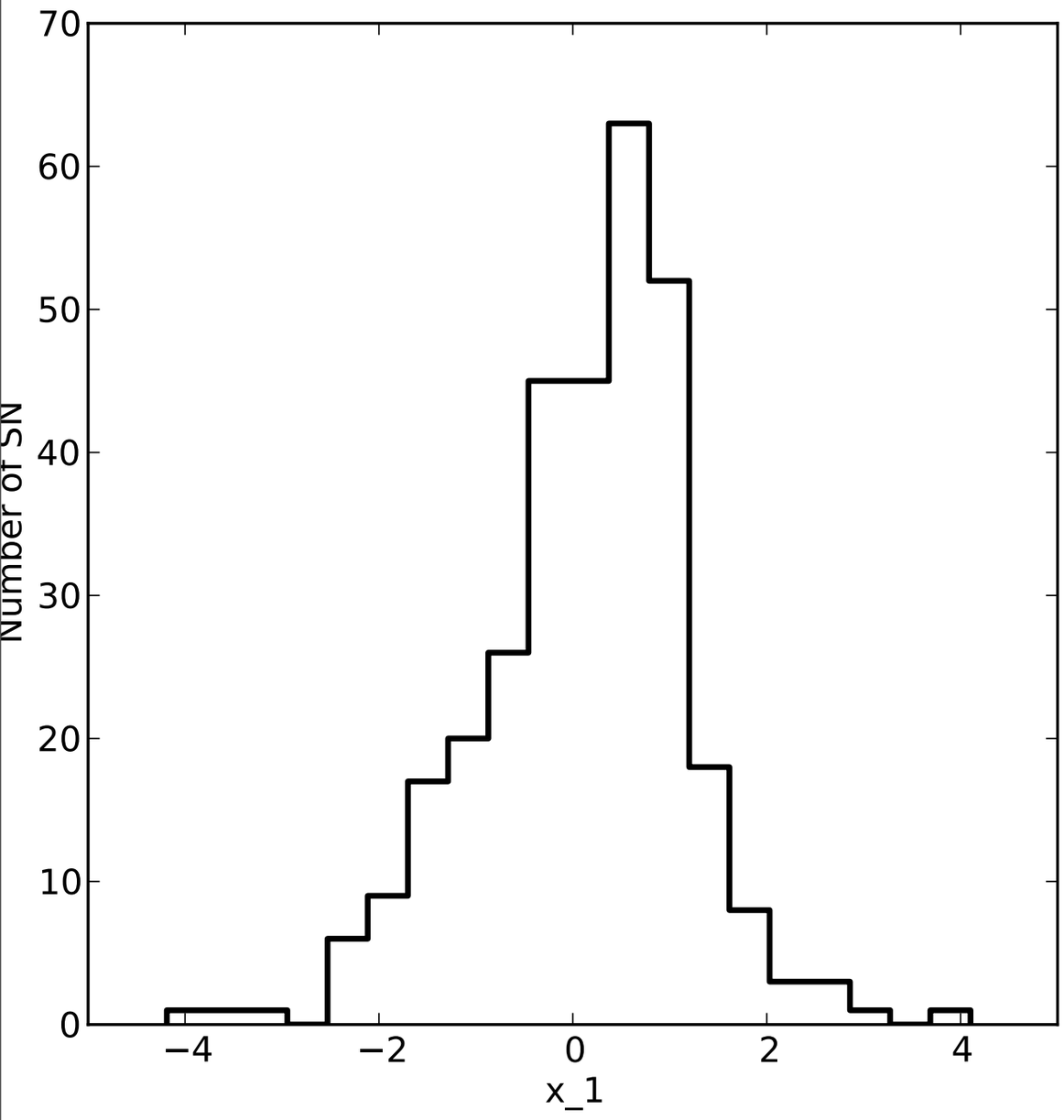


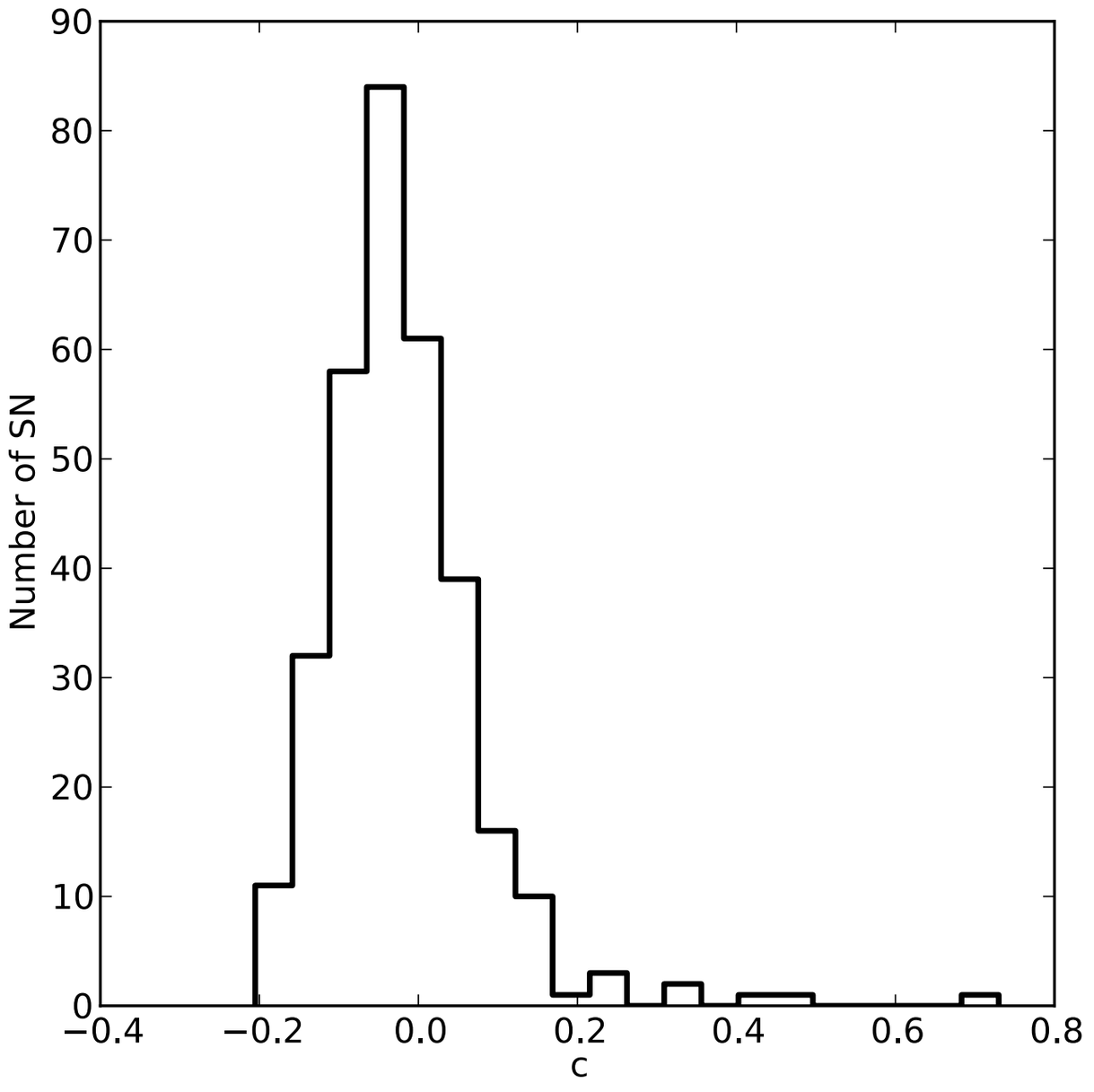






Typical Ranges

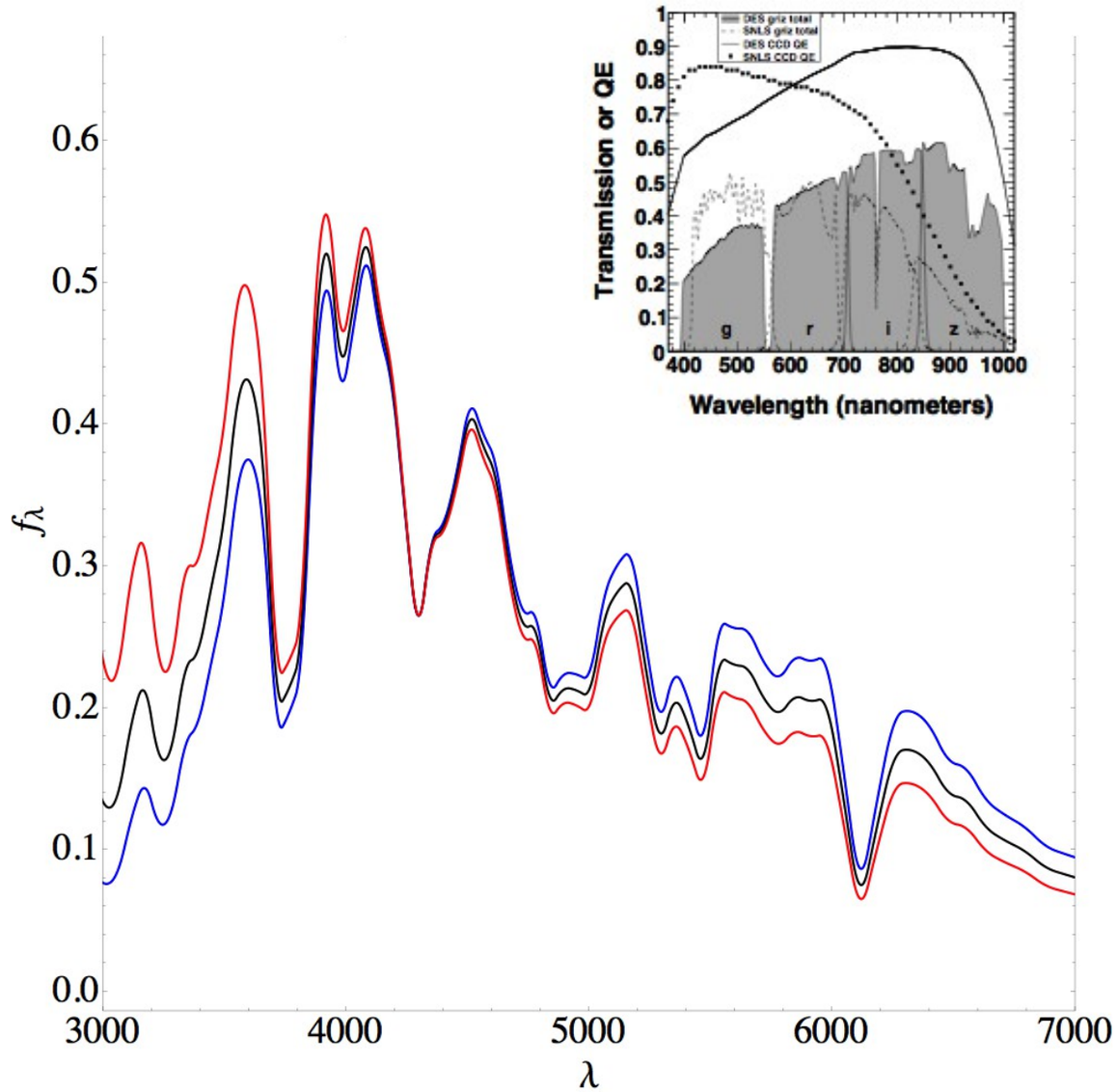




$$\mu = -2.5\log(x_0) + \alpha x_1 - \beta c + m0$$

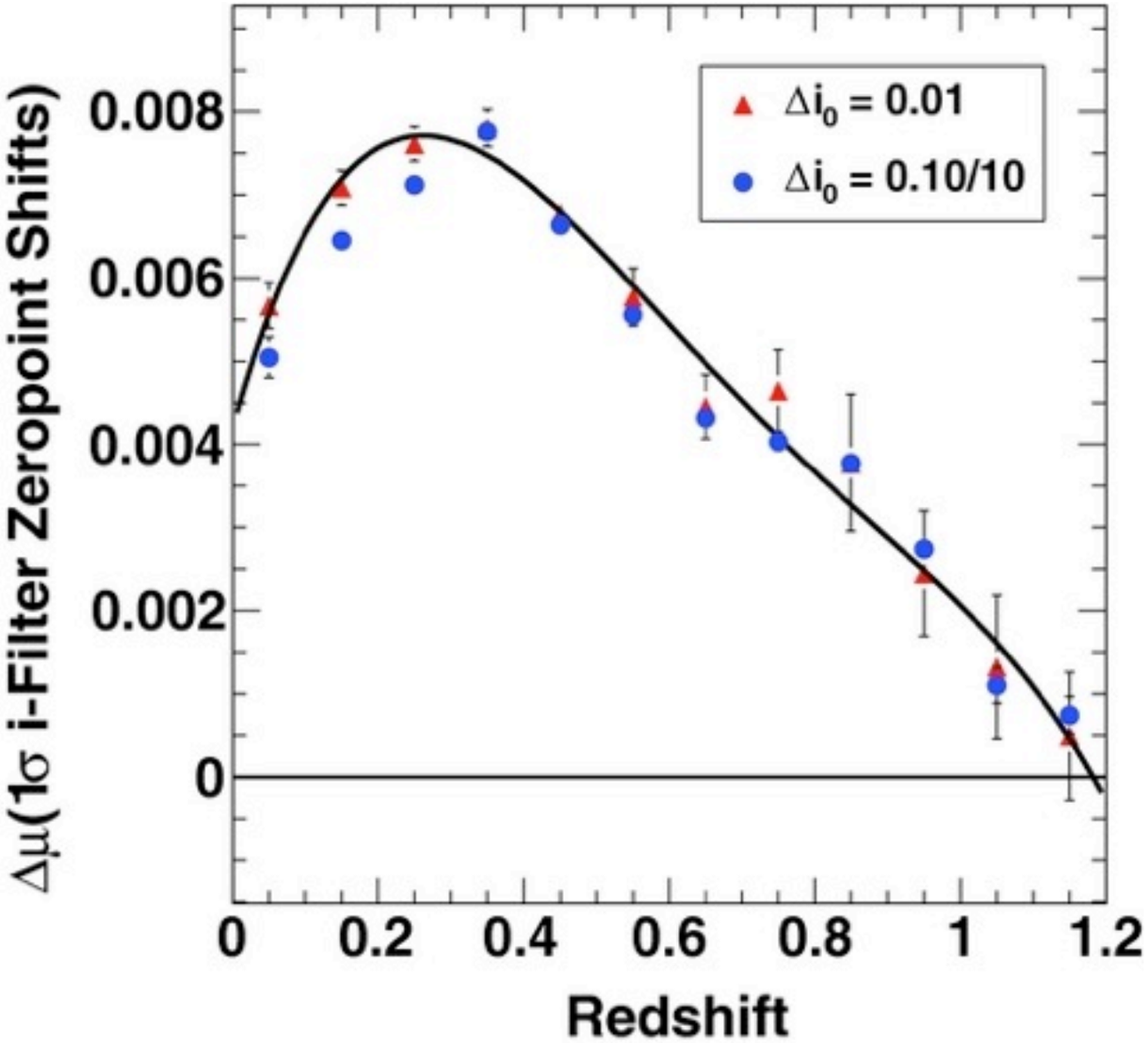
alpha ~ 0.1, beta ~3.1

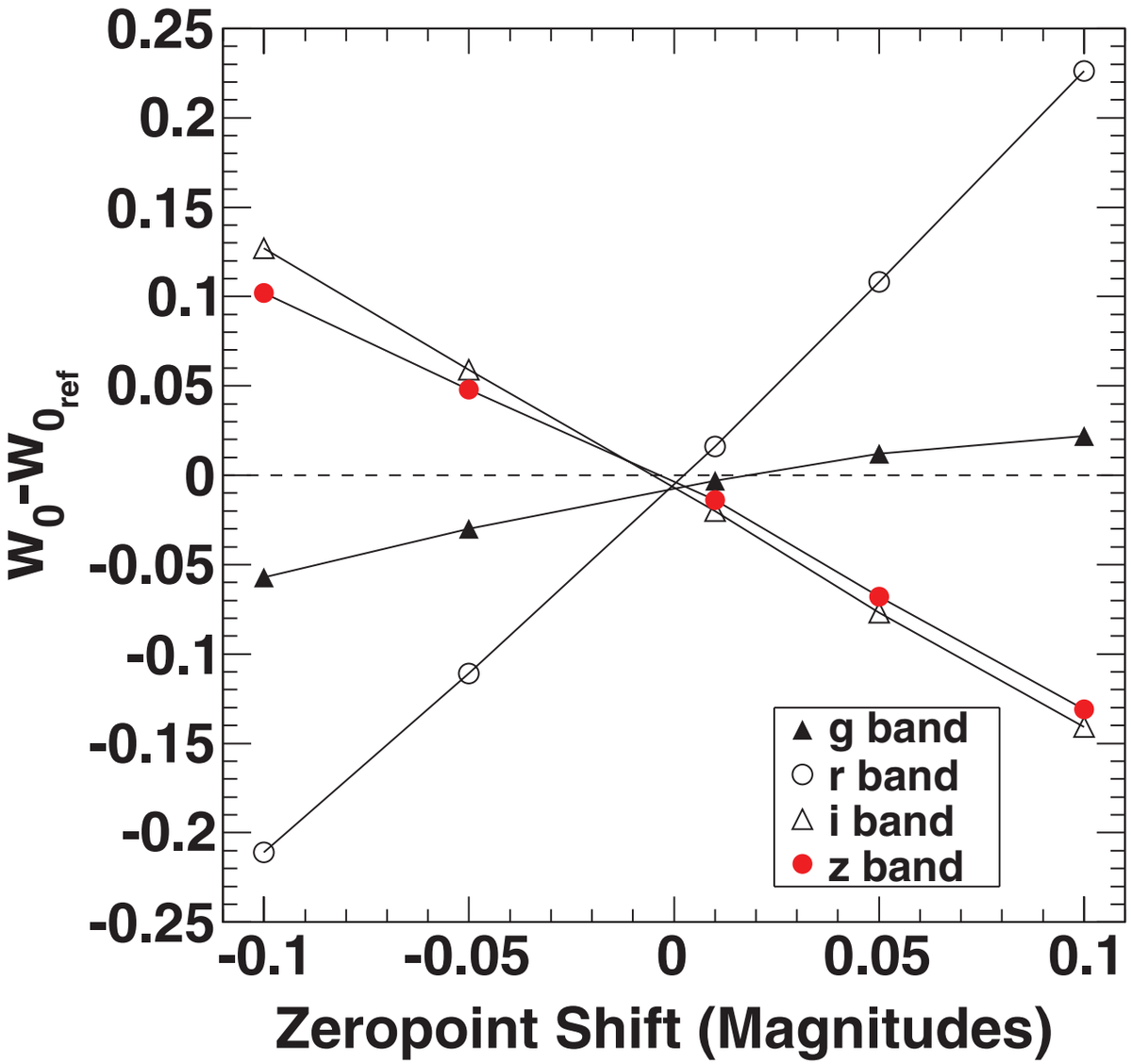
c changes spectral slope



calibration errors or uncertainties in filter transmission resulting in slopes affect c and hence cosmology

Measurement related systematics: calibration





Calibration systematics

- Has been considered as a major source of systematics. Also for DES forecasts.
- In current experiments, the effects are incorporated by computing a covariance matrix based derivates of distance modulus
- Use simulations to understand the effect of zero points as a model parameter, and marginalize over it.

Incorporating effects on Parameter estimates

- Have done this in forecasts, but can use the same idea for constructing likelihoods
- Improvements are possible by combining light curve fitting stage with parameter estimation (but computationally complicated)

Training systematics

- SN cosmology is based on comparing SN light curves to a model
- This model is determined from a data set of SN which is supposed to representative of the SN population
- The errors are propagated to light curve fits and thus cosmology

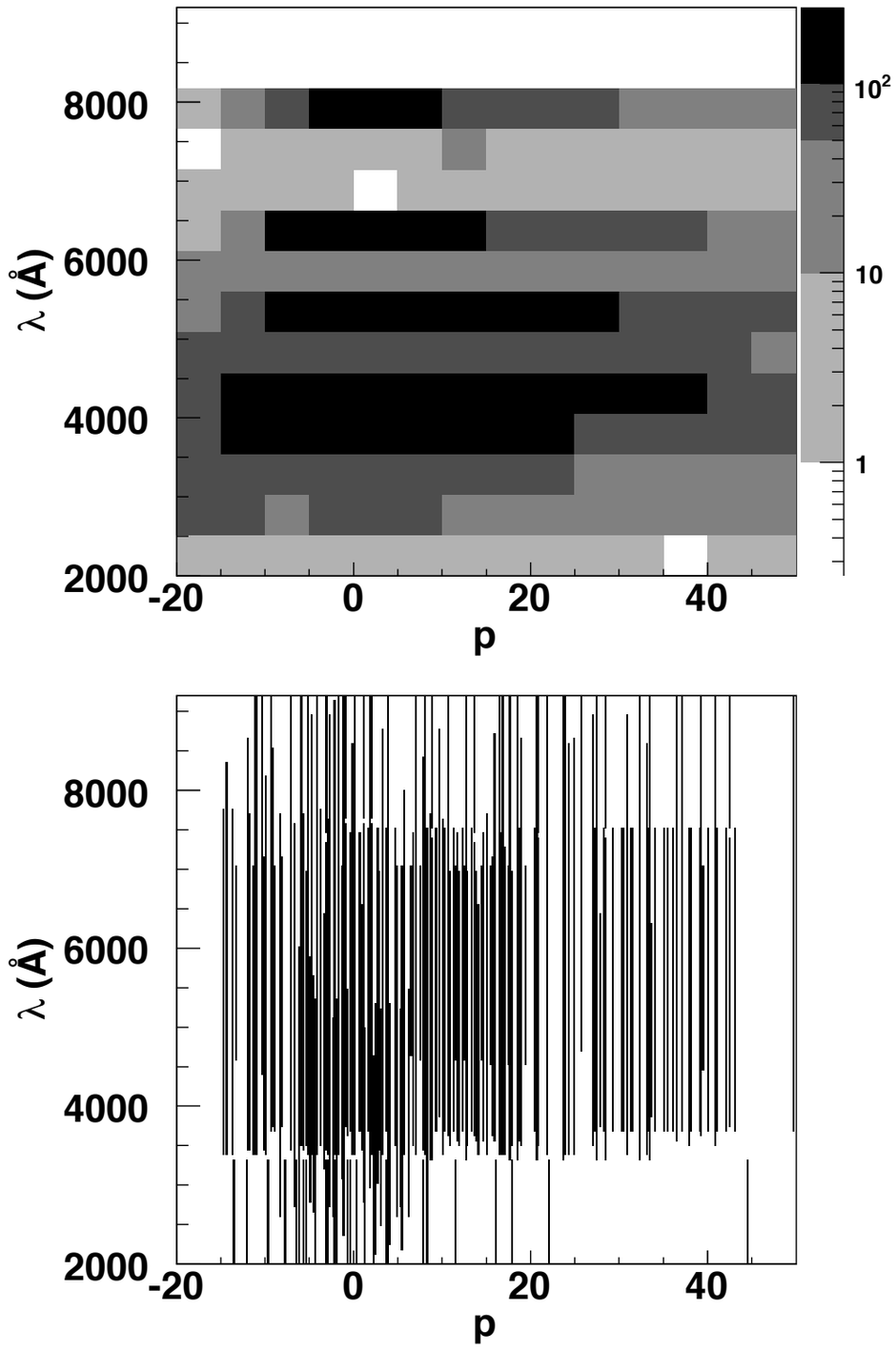
are the models and the errors correct?

Training Methodology

Global ML fit of SN parameters (x0, x1, c)

and the model parameters (M0, M1, Cl).

So, 3N + number of model parameters



Areas in phase space are sparsely sampled. Regularization added to the fitter. (or/and new data from SDSS)

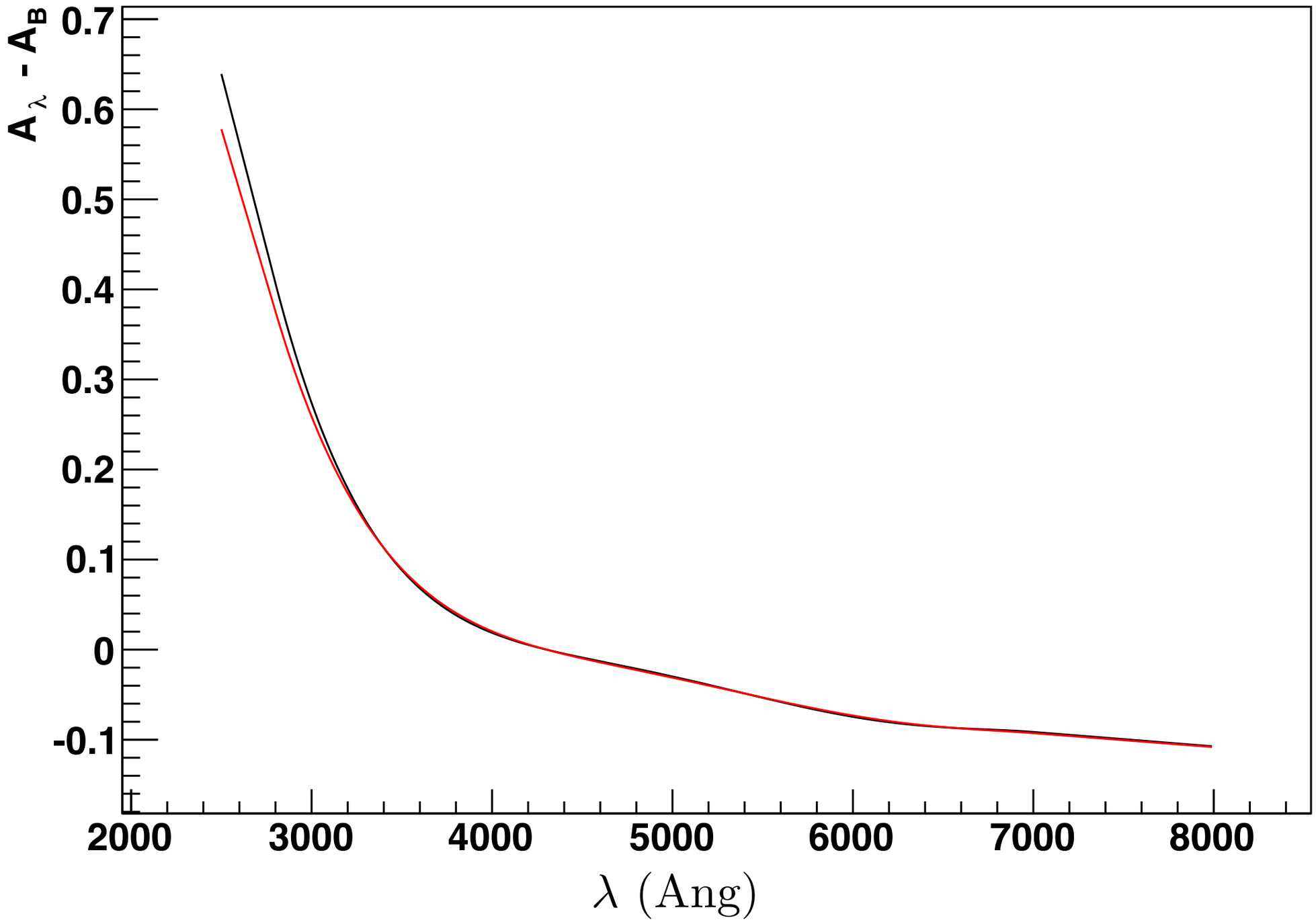
Errors from the fit (model error added in

quadrature to data errors

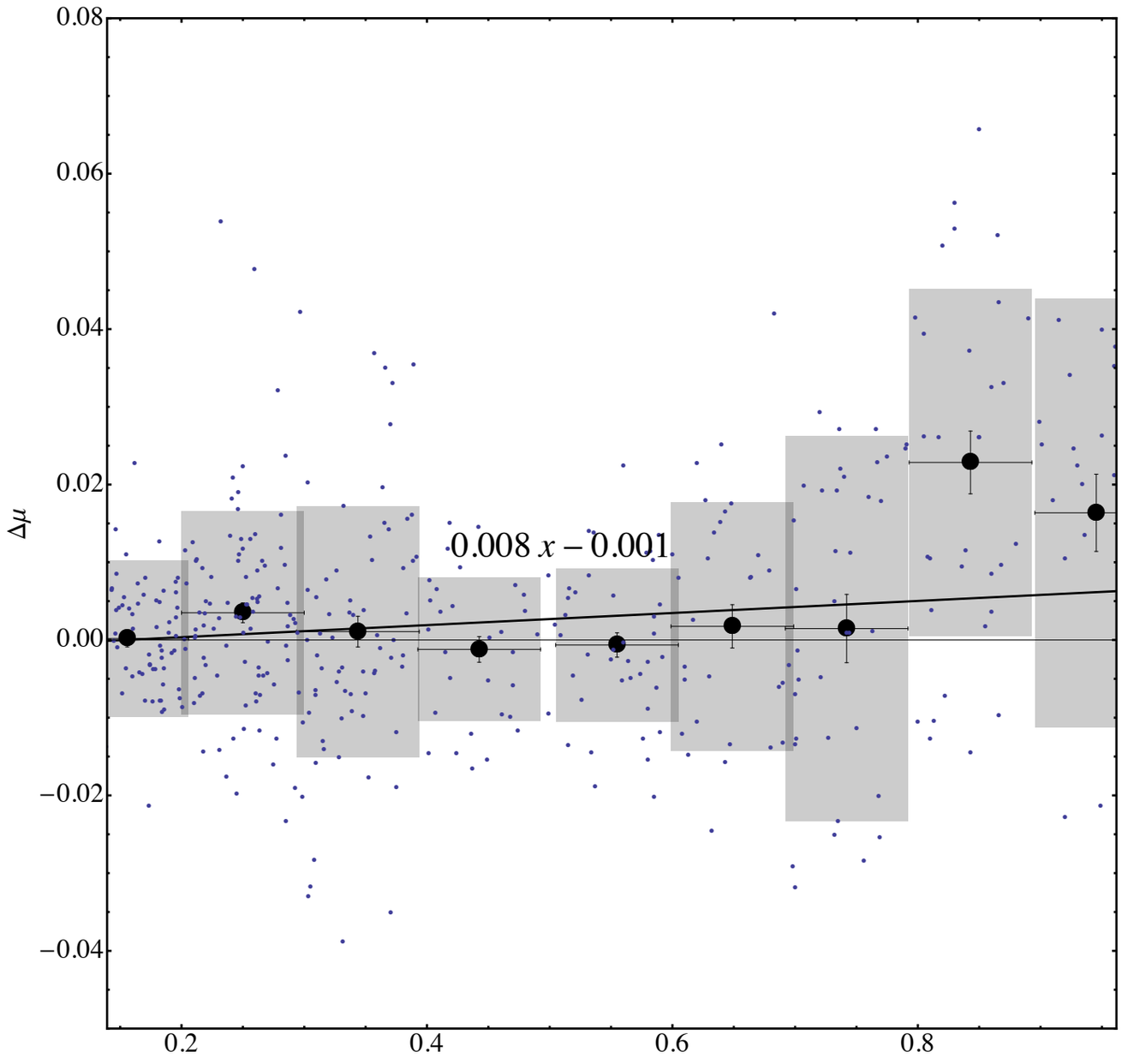
Assessing Errors in trainings

- Joint Light Curve Analysis Group: Study the recovery of cosmological parameters of a test simulated dataset using the light curve fitters
- Modifying the training sample with real SN and computing changes in distance moduli of a dataset.
- The main changes seem to affect the color law in the low wavelength region. Affects mu at high z.

Color Law Differences



Effect on estimating mu



- Has 219 SN from original training
- Additionally 284 LC from SDSS with the best choice of cuts

Has a negligible effect on wCDM cosmology, but could be still bad for SN at high redshifts

Summary

- Tighter constraints from SN involves larger number of SN requires much greater control of systematics
- Most systematics enter through the standardization of SN intrinsic brightness
- Observational uncertainties are dominated by calibration, but can be modelled
- Error in SN model may require further studies